

CLAIMS

1. An organic electroluminescence device emitting white light which comprises a pair of electrodes, at least two light emitting layers and an
5 electron transporting layer comprising a heterocyclic derivative having nitrogen atom or a heterocyclic derivative having silicon atom, the light emitting layers and the electron transporting layer being disposed between the pair of electrodes, wherein

an energy gap of a host compound comprised in each light emitting
10 layer $E_g(\text{Host-i})$ satisfies following relation (I):

$$2.9 \text{ eV} \leq E_g(\text{Host-i}) \quad \dots \text{ (I)}$$

wherein $E_g(\text{Host-i})$ represents an energy gap of a host compound comprised in an i-th light emitting layer from the electron transporting layer, i representing an integer of 1 to n,

15 an energy gap of the heterocyclic derivative having nitrogen atom or the heterocyclic derivative having silicon atom comprised in the electron transporting layer $E_g(\text{ETM})$ satisfies following relation (II):

$$2.9 \text{ eV} < E_g(\text{ETM}) \quad \dots \text{ (II)}$$

and

20 an ionization potential of a host compound comprised in a light emitting layer adjacent to the electron transporting layer ($I_p(\text{Host-1})$) and an ionization potential of the heterocyclic derivative having nitrogen atom or the heterocyclic derivative having silicon atom comprised in the electron transporting layer ($I_p(\text{ETM})$) satisfy following relation (III):

25 $I_p(\text{ETM}) \leq I_p(\text{Host-1}) + 0.3 \text{ eV} \quad \dots \text{ (III)}$

2. The organic electroluminescence device emitting white light according to Claim 1, wherein the energy gap of a host compound comprised in each light emitting layer $E_g(\text{Host-i})$ and the energy gap of the heterocyclic derivative having nitrogen atom or the heterocyclic derivative having silicon atom comprised in the electron transporting layer $E_g(\text{ETM})$ satisfy following relation (IV):

$$2.9 \text{ eV} < E_g(\text{ETM}) \leq E_g(\text{Host-i}) \quad \dots \text{ (IV)}$$

3. The organic electroluminescence device emitting white light according to any one of Claims 1 and 2, wherein at least one light emitting layer comprises a dopant having an energy gap of 2.9 eV or smaller.

4. The organic electroluminescence device emitting white light according to any one of Claims 1 and 2, which comprises at least two light emitting layers having different peak wavelengths of light emission.

5. The organic electroluminescence device emitting white light according to any one of Claims 1 and 2, wherein a difference between a greatest peak wavelength of light emission and a second greatest peak wavelength of light emission is 50 nm or greater.

6. The organic electroluminescence device emitting white light according to Claim 1, wherein the electron transporting layer or an interfacial region between the electron transporting layer and a cathode comprises a metal having a work function of 2.8 eV or smaller or a compound of the metal.

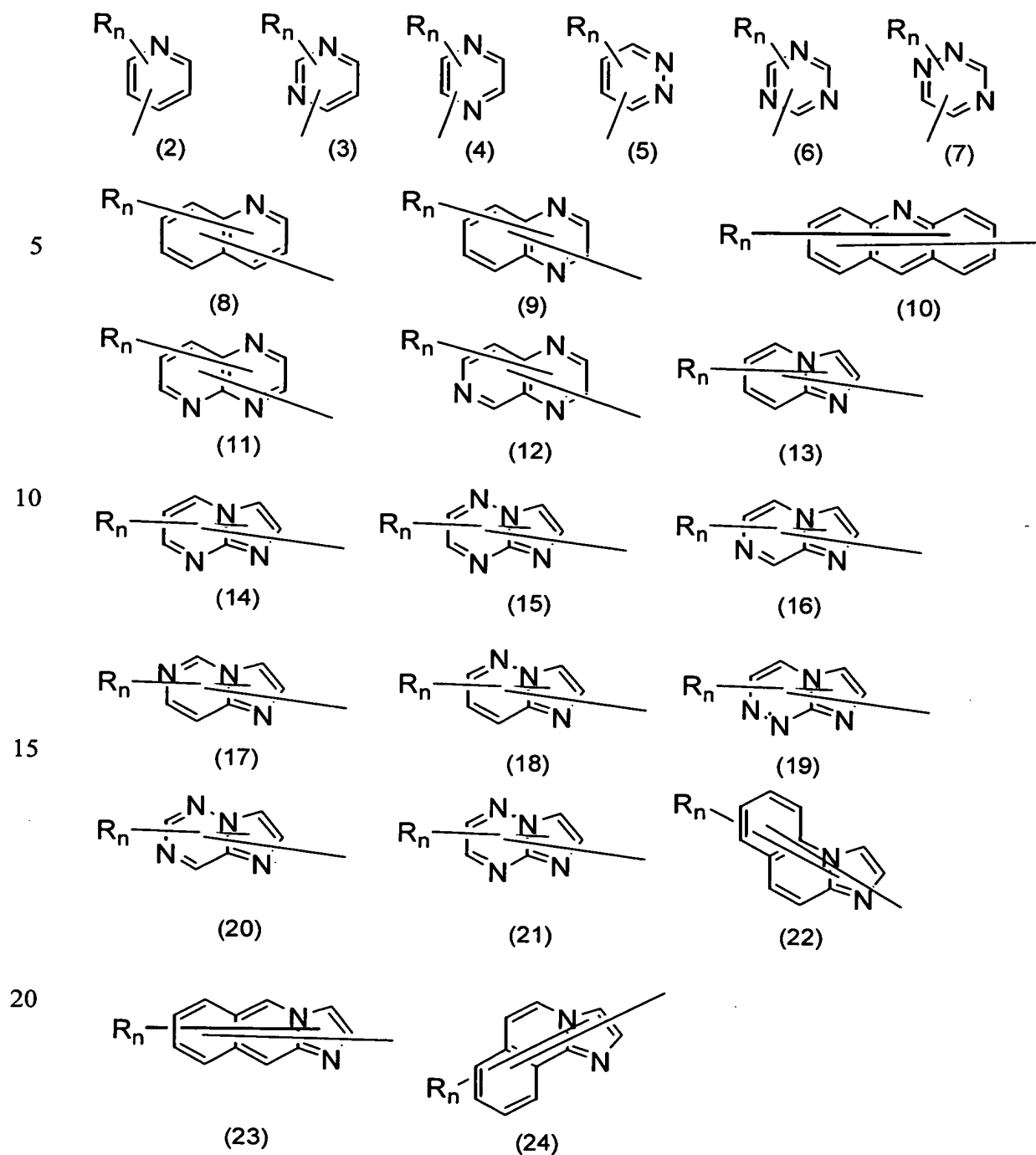
7. The organic electroluminescence device emitting white light according to Claim 6, wherein the metal is Na, K, Rb, Cs, Ca, Sr or Ba.

- 5 8. The organic electroluminescence device emitting white light according to any one of Claims 1 and 2, wherein the electron transporting layer comprises a heterocyclic derivative having nitrogen atom represented by following general formula (1):



- 10 wherein HAr represents a substituted or unsubstituted heterocyclic group having nitrogen atom, Ar¹ represents a substituted or unsubstituted divalent aromatic hydrocarbon group having 6 to 40 carbon atoms, Ar² represents a substituted or unsubstituted aryl group having 6 to 40 carbon atoms or a substituted or unsubstituted heteroaryl group having 3
15 to 40 carbon atoms, and L represents a single bond or a substituted or unsubstituted arylene group.

9. The organic electroluminescence device emitting white light according to Claim 8, wherein HAr represents a heterocyclic group represented by
20 one of following formulae (2) to (24):

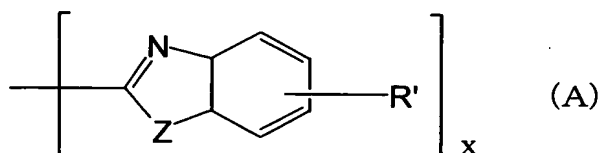


wherein R represents a substituted or unsubstituted aryl group having 6
 25 to 40 carbon atoms, a substituted or unsubstituted heteroaryl group
 having 3 to 40 carbon atoms, a substituted or unsubstituted alkyl group

having 1 to 20 carbon atoms or a substituted or unsubstituted alkoxyl group having 1 to 20 carbon atoms, n represents an integer of 0 to 5 and, when n represents an integer of 2 or greater, a plural R may represent a same group or different groups, and the plurality of groups represented by

5 R may be bonded to each other to form a cyclic structure;

and formula (A):



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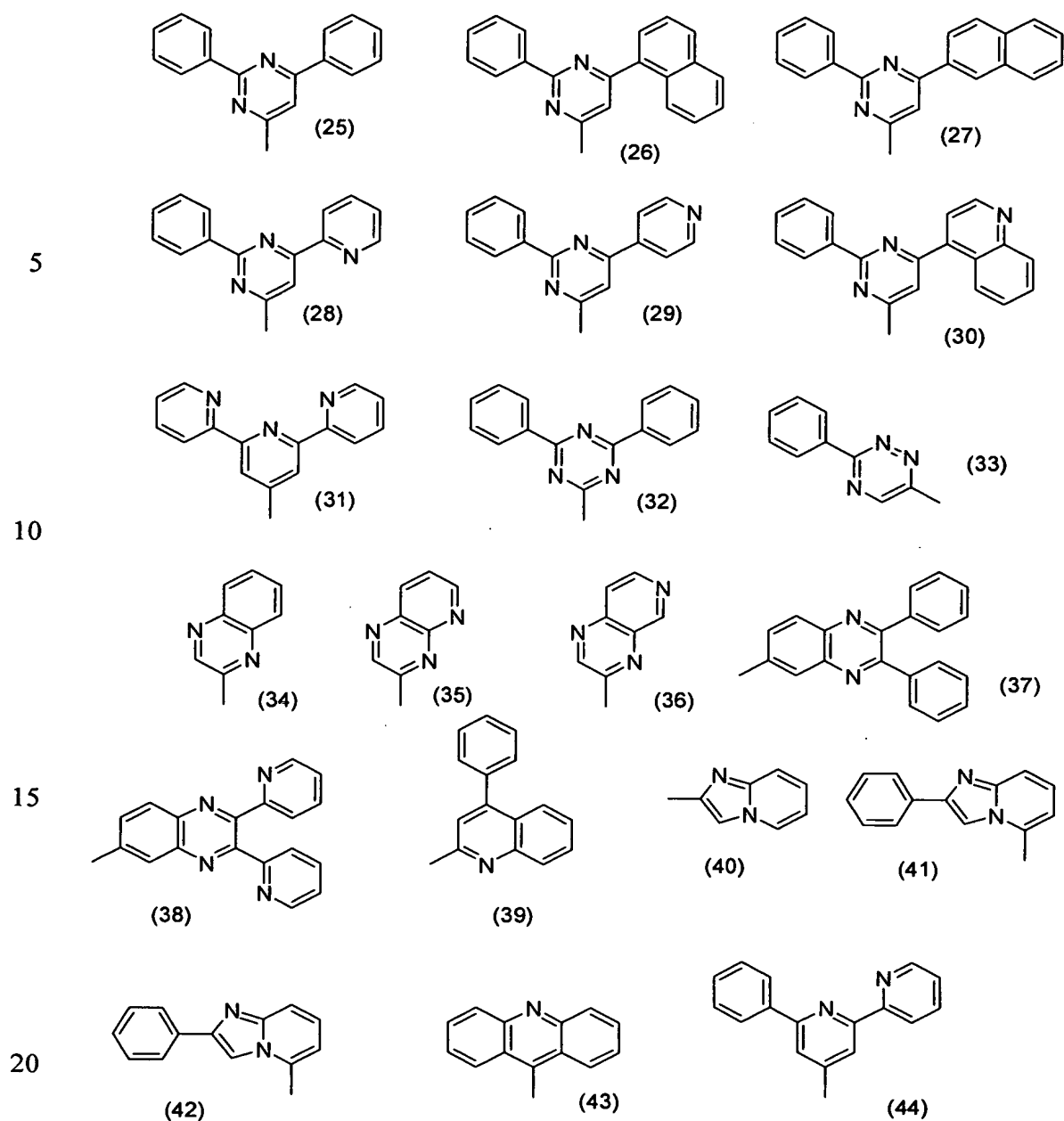
wherein a plural R^1 each independently represent hydrogen atom, a halogen atom, a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, a substituted or unsubstituted heteroaryl group having 3 to 40 carbon atoms or a group forming a condensed aromatic group, Z represents oxygen atom, sulfur atom or a group represented by NR' , R' representing a same atom or group as that represented by R^1 , and x represents an integer of 2 to 8;

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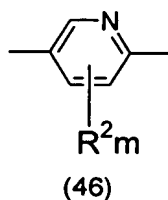
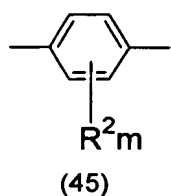
or a substituted or unsubstituted carbazolyl group.

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10. The organic electroluminescence device emitting white light according to Claim 8, wherein HAr represents a group expressed by one of following formulae (25) to (44):

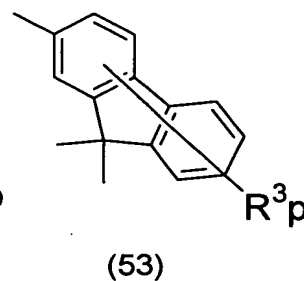
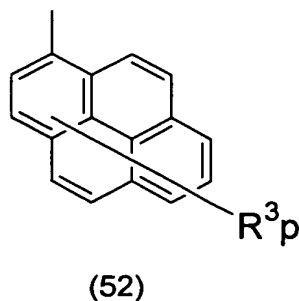
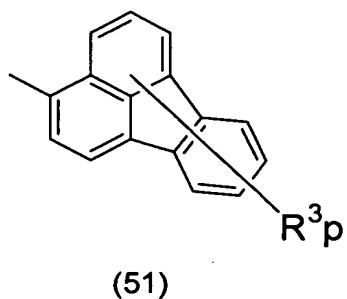
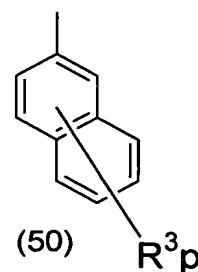
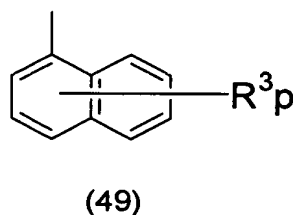
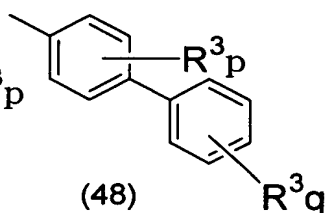
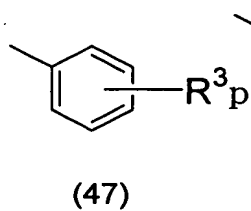


11. The organic electroluminescence device emitting white light according to Claim 8, wherein L represents a group represented by one of following formulae (45) and (46):



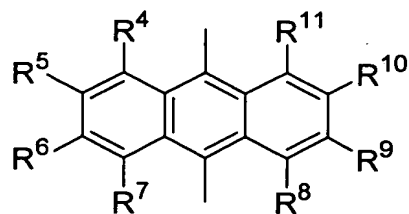
5 wherein R^2 represents a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, a substituted or unsubstituted heteroaryl group having 3 to 40 carbon atoms, a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms or a substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, m represents an integer of 0 to 4 and,
 10 when m represents an integer of 2 or greater, a plural R^2 may represent a same group or different groups, and a plural group represented by R^2 may be bonded to each other to form a cyclic structure.

12. The organic electroluminescence device emitting white light according
 15 to Claim 8, wherein Ar^2 represents a group represented by one of following formulae (47) to (53):

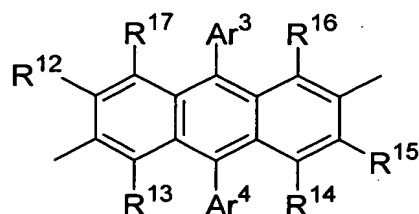


wherein R^3 represents a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, a substituted or unsubstituted heteroaryl group having 3 to 40 carbon atoms, a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms or a substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, p represents an integer of 0 to 9, q represents an integer of 0 to 5 and, when p or $p+q$ represents an integer of 2 or greater, a plural R^3 may represent a same group or different groups, and a plural group represented by R^3 may be bonded to each other to form a cyclic structure.

13. The organic electroluminescence device emitting white light according to Claim 8, wherein Ar^1 represents a group represented by one of following formulae (54) and (55):



(54)



(55)

wherein R^4 to R^{17} each independently represent hydrogen atom, a halogen atom, a substituted or unsubstituted aryl group having 6 to 40 carbon atoms, a substituted or unsubstituted aryloxy group having 6 to 40 carbon atoms, a substituted or unsubstituted heteroaryl group having 3 to 40 carbon atoms, a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms or a substituted or unsubstituted alkoxy group having 1 to 20 carbon atoms, and Ar^3 and Ar^4 each represent a substituted or

unsubstituted aryl group having 6 to 40 carbon atoms or a substituted or unsubstituted heteroaryl group having 3 to 40 carbon atoms.